The Open University

Science
S382 Astrophysics

S382

Tutor-Marked Assignment 02

Please send all your answers to the tutor-marked assignment (TMA) to reach your tutor by 12 noon (UK local time) on or before the cut-off date shown on the S382 website. Your TMAs should be submitted through the eTMA system unless there are difficulties which prevent you from doing so. In these circumstances, you must negotiate with your tutor to get their agreement to submit your assignment on paper. The eTMA system allows for eTMA submission directly to the university 24 hours a day, and either gives you confirmation that your eTMA has been submitted successfully or, if there has been a problem, an error message informing you of the problem and what steps you can take to overcome it. If you submit online you must keep your receipt code in case you need to prove successful submission.

General information about policy and procedure is in the *Assessment Handbook* which you can access from StudentHome. However, there are a number of ways in which S382 eTMA submission differs from what is described there. These are described in the document *Producing eTMAs for Level 3 physics and astronomy modules* on the S382 website. See also the S382 *Introduction and Guide* for module-specific information.

Of particular importance is the test submission, TMA 00. This will enable you to familiarize yourself with the system and allow your tutor to check that the format in which you save your TMAs is compatible with their own computer software. It is your responsibility to make sure that you submit documents in a compatible format and we strongly recommend that you submit TMA 00. TMAs submitted in an incorrect format may not be marked.

If you are submitting a paper copy, please allow sufficient time in the post for the assignment to reach its destination on or before the cut-off date. We strongly advise you to use first-class post and to ask for proof of postage. Do not use recorded delivery or registered post as your tutor may not be in to receive it. Keep a copy of the assignment in case it goes astray in the post. You should also include an appropriately completed assignment form (PT3). You will find instructions on how to fill in the PT3 form in the *Assessment Handbook*. Remember to fill in the correct assignment number (02).

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2.1 PT/TeX

Although the marks for your assignments do not count directly towards your S382 result, they are an essential part of your learning and you are required to engage satisfactorily with them. Please refer to the S382 *Introduction and Guide* for additional information about the module assessment.

Assignment cut-off dates
The cut-off dates for the assignments provide an important element of pacing for your study of S382 and they are spread fairly uniformly through the year, leading up to the exam. **You should regard these dates as fixed points**. *Any extension to a TMA cut-off date requires prior permission from your tutor, which may not always be given. Extensions may be granted in exceptional circumstances but it will never be possible to have an extension of more than 3 weeks.* Your tutor will, of course, be willing to discuss with you the best strategies for catching up if you have fallen behind, and should be able to help with questions if you are stuck.

Marking of assignments
As explained in the *Introduction and Guide*, all the assignments for S382 are *formative*. They are designed to help with the teaching of the module not its assessment, and the scores you obtain for them *do not* count towards your overall grade. Nonetheless, **you are required to satisfactorily complete at least 8 out of 10 of the TMAs and iCMAs** in order to be considered for a grade based on the examinable assessment components (i.e. the exam covering Parts 1 and 3 of the module and the project portfolio covering Part 2 of the module).

The assignment questions allow you to demonstrate that you have achieved particular learning outcomes for the module. These learning outcomes are listed in Section 2 of the *Introduction and Guide*. They include knowledge and understanding of the module content, the ability to apply this knowledge and understanding to the solution of problems in astrophysics, the ability to explain concepts, phenomena and applications in astrophysics, and the ability to communicate effectively your solutions and explanations. In each assignment booklet we indicate which of the learning outcomes are assessed in the assignment, and which parts of the questions relate to which learning outcomes.

When commenting on your assignment answers, your tutor will be assessing the extent to which you have achieved the learning outcomes. This will include assessing whether you have got the correct answer, but also whether you have explained your reasoning, whether your answers are well-structured (both for numerical and discursive answers), and whether you have used correct terminology and notation, and so on. For each of the learning outcomes that are assessed, your tutor will allocate a descriptor to indicate your level of achievement, which will be one of: well demonstrated, demonstrated, just demonstrated, not quite demonstrated, not demonstrated (or not attempted).

Plagiarism
You are encouraged to discuss the S382 materials and assignment questions with other students, but the answers to the assignment questions must be your own work. This does not preclude you from making judicious use of material from other sources, but you must acknowledge such use by giving the author's name, the year of publication, the name of the publication in which it appears (or the website address), and the edition or volume number and the page number. However, there is no need to give references for standard equations in the S382 texts. You are advised to read the University's guidelines on plagiarism, see the *Introduction and Guide* for more details.

To check that all students are working in a fair and academically appropriate manner, the Open University is currently using some text-comparison software to detect potential cases of plagiarism in work that is submitted for assessment. Details of how this is implemented in this module are given on the S382 website.

Further general advice on answering S382 assignment questions is given with TMA 01.

TMA 02 CUT-OFF DATE: SEE S382 STUDY PLANNER

This assignment covers Chapters 5 and 6 of *Stellar Evolution and Nucleosynthesis*. It allows you to assess your ability to achieve the following learning outcomes:

Kn1: Knowledge and understanding of the terminology used to describe the properties and behaviour of isolated stars.
Kn2: Knowledge and understanding of basic concepts of nuclear physics and particle physics, that are of relevance to astrophysics and cosmology.
Kn3: Knowledge and understanding of the properties of stars at different stages of their evolution, – how they form, what happens to them as they age, and what becomes of them when they die.
Kn5: Knowledge and understanding of the relationship between different stages of stellar evolution and the production of the chemical elements.
Ky1: Organize and clearly present relevant information in response to defined tasks, including the expression of mathematical and scientific concepts using clear, concise and correct scientific prose.

Question 1

This question concerns the late stages of stellar evolution discussed in Chapters 5 and 6, and in particular the nuclear reactions that occur late in the lives of high-mass stars.

(**All parts of this question are assessed against Learning Outcome Ky1.**)

(a) (**Learning outcome Kn5**)
Explain quantitatively why helium burning via the first and second steps of the triple-alpha process cannot proceed until a star's core temperature reaches about 10^8 K.

(Your answer should be no more than 250 words.)

(b) (**Learning outcome Kn3**)
What are the evolutionary end-points of main-sequence stars with masses of (i) $0.4\,M_\odot$, (ii) $5\,M_\odot$, and (iii) $10\,M_\odot$? Explain the reason for the composition of the compact remnant in each case, and whether or not each will experience the helium flash during its evolution.

(Your answer should be no more than 250 words.)

(c) (**Learning outcome Kn5**)
Four of the most abundant elements in the Earth's crust are oxygen, magnesium, silicon and iron. Explain how *each* of these elements was produced in stars which lived and died before the Earth was formed.

(Your answer should be no more than 500 words plus equations.)

(d) (i) (**Learning outcome Kn1**)
Explain what are the requirements, in terms of the neutron flux, for the s-process and the r-process for neutron-capture nucleosynthesis, and hence explain in what environments each process might be expected to occur.

(ii) (**Learning outcome Kn2**)
Strontium (atomic number $Z = 38$) is an alkaline earth metal and is the 15th most abundant element in the Earth's crust. It occurs in four stable isotopes, namely strontium-84, -86, -87, and -88. Referring to Figure 6.9, explain the origin of each of these isotopes. Comment also on why strontium is so abundant.

(Your answers to parts (i) and (ii) should each be no more than 200 words.)

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